SPECIFICATION

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[BRAKE PEDAL SYSTEM FOR IMPROVED BRAKING PERFORMANCE]

Background of Invention

[0001] The present invention relates generally to brake systems for automotive vehicles, and more particularly, to a brake pedal assist system.

[0002] Automotive brake systems are the result of a long evolutionary process and are one of the most important systems in a vehicle. Typical brake systems include a master cylinder, located under the hood, which is directly connected to a brake pedal. The master cylinder converts mechanical pressure applied to the brake pedal into a proportional amount of hydraulic pressure. This hydraulic pressure is used to actuate the vehicle brakes. Many brake systems also use the engine's energy to add pressure to the master cylinder.

[0003] Recent vehicle data indicates that drivers do not utilize the brake system effectively. When the brake system is used, it is often applied too late. To improve upon driver performance, various warning systems for notifying the driver to apply the brakes have been suggested in the prior art. U.S. Patent No. 5,410,304 discloses a method and apparatus for displaying the impending danger due to speed associated with the driving situation of a vehicle. The apparatus uses a visual display to warn a driver as to the degree of imminent danger/risk.

[0004] U.S. Patent No. 6,243,024 discloses a device for monitoring the surroundings of a vehicle. Operating and control circuits activate light emitting diodes depending on a degree of risk. The '024 patent detects objects using radar and determines the possibility of collisions with these objects. This is displayed to the driver using a

visible warning to convey a degree of risk and/or safety.

[0005] U.S. Patent No. 5,777,563 discloses a method and assembly for object detection by a vehicle. The assembly calculates and provides an audible warning and a visible indicator signal to the driver based on the degree of closeness of a target vehicle.

[0006] U.S. Patent No. 5,781,103 discloses a vehicle cruise control system. This apparatus calculates the magnitude of necessary braking and 'indicates' to the driver when the apparatus is employing the maximum braking force allowed by the system. The indication to the driver may be audible, visual or by touch.

[0007] Unfortunately, the systems suggested by these patents have several disadvantages. The warnings suggested by the prior art are very dependent on driver attentiveness. They will not notify a driver that may be visually and audibly distracted. Additionally, none of the prior art warnings help to assist the driver decelerate the vehicle.

[0008] The disadvantages associated with these conventional braking stimulation techniques have made it apparent that a new technique is needed. The new technique should provide adequate notification for braking while enhancing driver performance. The present invention is directed to these ends.

Summary of Invention

[0009] It is, therefore, an object of the invention to provide an improved and reliable brake system.

[0010] In accordance with the objects of this invention, a brake assist system is provided. The brake system includes a brake pedal connected to a brake pedal actuator for applying a variable brake feel force to the brake pedal. A forward detection apparatus is used to detect the relative distance and speed to a target vehicle. A controller monitors the relative distance and speed to notify the driver to slow down. Upon application of the brake, the brake feel force is reduced in proportion to the level of threat detected. In this way, the driver is induced to apply an increased brake pedal force.

[0011] The present invention thus achieves an improved brake system. The present

invention is advantageous in that it enhances driver braking performance.

[0012] Additional advantages and features of the present invention will become apparent from the description that follows, and may be realized by means of the instrumentalities and combinations particularly pointed out in the appended claims, taken in conjunction with the accompanying drawings.

Brief Description of Drawings

[0013] In order that the invention may be well understood, there will now be described some embodiments thereof, given by way of example, reference being made to the accompanying drawings, in which:

[0014] FIGURE 1 illustrates a brake system in accordance with one embodiment of the present invention; and

[0015] FIGURE 2 is a braking apparatus in accordance with one embodiment of the present invention.

Detailed Description

[0016] In the following figures, the same reference numerals will be used to identify identical components in the various views. The present invention is illustrated with respect to a brake system, particularly suited for the automotive field. However, the present invention is applicable to various other uses that may require a brake pedal system.

[0017] Referring to FIGURE 1, a brake system 10 according to one embodiment of the present invention will be described. A vehicle 11 is provided with a brake system 26 having brake mechanisms 12 and 14 for front and rear wheels 16 and 18, respectively. In one aspect of the invention, brake mechanisms 12 and 14 comprise disc rotors 12a and 14a rotating with wheels 16 and 18, calipers 12b and 14b for braking the rotation of disc rotors 12a and 14a when hydraulic fluid for braking control is supplied. Further, vehicle 11 comprises a forward detection apparatus 20 for detecting the distance and relative speed between the driving vehicle 10 and the leading vehicle 22 by irradiating laser beams, infrared, radar, microwave or equivalent detection means. Vehicle 11 also includes a braking apparatus 23 having a controller

24 receiving signals from the forward detection apparatus 20.

[0018] The intention of the present invention is to mitigate or avoid imminent frontal contact by means of encouraging the driver to apply an increased force to brake pedal 28. Application of the present invention should occur before the opportunity to steer away from the threat is passed. Preliminary efficiency estimations show that contact may be avoided with appropriate brake application.

[0019] Referring to FIGURE 2, a braking apparatus 23 according to one embodiment of the present invention will be described. A brake pedal 28 operated by the driver (not shown) exerts a brake pedal force upon a variable brake booster 30 and is coupled to a brake position sensor. A brake pedal actuator 33 is coupled to brake pedal 28 and controls the brake feel of brake pedal 28 by applying a brake feel force. The braking system 26 is coupled to the variable brake booster 30 that produces a variable brake booster force causing the braking system 26 to exert a braking force proportional to the pedal force.

[0020] An accelerator pedal 29 controls engine speed and is coupled to an accelerator position sensor. An accelerator actuator 31 is coupled to accelerator pedal 29 and may apply a variable force to accelerator pedal 29 to provide braking stimulation to the driver. The forward detection apparatus 20 detects a relative distance and speed to vehicle 22 and signals controller 24.

[0021] Controller 24 notifies the driver to decelerate vehicle 11. In the preferred embodiment, the notification is a physical signal transmitted to the driver through brake pedal 28. One skilled in the art, however, would realize that the notification might be through an audible or visible signal. The level of notification given to the driver is proportional to the distance and the relative speed between vehicle 11 and vehicle 22. In many situations, this would involve slightly reducing the brake feel force to brake pedal 28 for low threat situations and increasing the amount of brake feel reduction as the threat increases. The reduction in brake feel force should not reduce brake pedal travel significantly or have an adverse effect on braking performance. One advantage of this technique is that the reduction of brake feel force will encourage the driver to apply an increased amount of force to brake pedal 28. This system is particularly suited to brake-by-wire applications where brake pedal feel and travel is a

function of the brake-by-wire system.

[0022] In the preferred embodiment, the level of brake feel reduction is a continuous function of relative speed, relative distance, and target classification. For an audible signal this would involve varying the signal frequency and volume based upon the level of the threat. For low threats the audible signal would have a low volume and frequency. For higher threats the audible signal would have an increased volume level and frequency. For a visible signal this would involve varying the color and intensity of the signal. The visible signal would use a muted color and low intensity for low threat levels and brighter color and higher intensity for increased threat levels. Additionally, any of these signals may be pulsed with a low frequency for low level threats and a high intensity for high level threats.

[0023] The method and system of the present invention enhances driver performance during braking situations. Additionally, the present invention improves vehicle deceleration based on a variable threat level.

[0024] From the foregoing, it can be seen that there has been brought to the art a new and improved brake system. It is to be understood that the preceding description of the preferred embodiment is merely illustrative of some of the many specific embodiments that represent applications of the principles of the present invention. Clearly, numerous and other arrangements would be evident to those skilled in the art without departing from the scope of the invention as defined by the following claims: